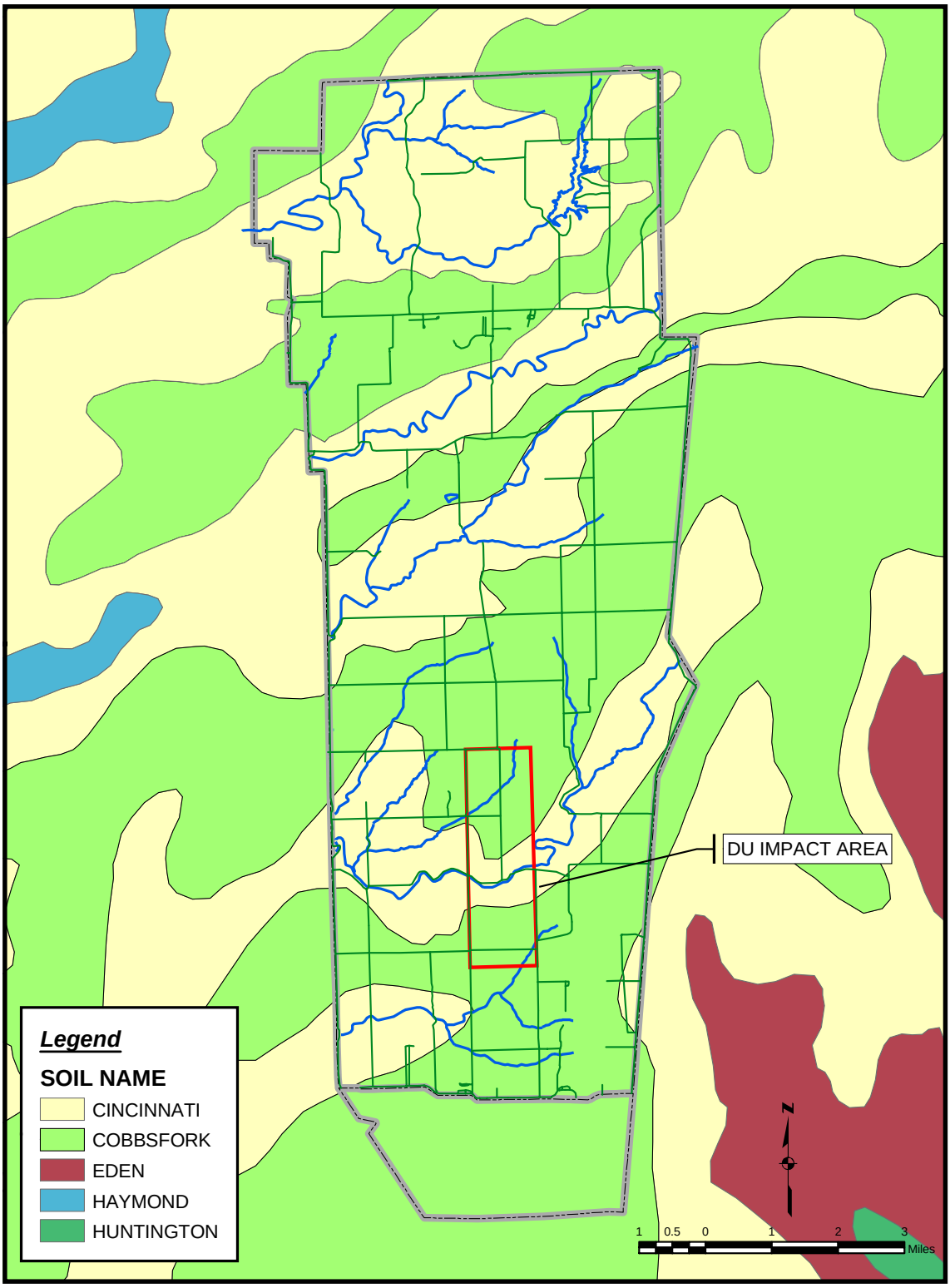


Figure 2-6. Major Soil Associations Present at JPG

The nearly level and gently sloping, moderately drained Rossmoyne soils are located on summits, shoulder slopes, and upper back slopes and have a low-permeability fragipan in the subsoil. Typically, these soils have a dark brown silt loam surface layer about 8 in. (0.23 m) thick. The gently sloping to moderately sloping, well-drained Cincinnati soils are located on summits, shoulder slopes, and back slopes and have a low-permeability fragipan in the subsoil. The dark brown surface layer is about 6 in. thick (MWH 2002).

Soils with the DU Impact Area vary depending on the location. Six different types of soils occur either on or adjacent to stream beds. These soils are described as silt loam, loam, and silty clay loam. At more inland locations, the soil type is generally deep and moderately well drained, with slopes of 0 to 35%, occurring mainly on the ridge tops, breaks, and hillsides. Further inland, the soil type is generally nearly level to gently sloping, somewhat poorly drained, and located on tabular divides (U.S. Army 1995b).

Seismology

The U.S. Geological Survey (USGS) maps of seismic hazards published in 1997, for Central and Eastern United States (CEUS), were reviewed to determine the potential seismic hazard for the JPG site (USGS 2001a). The number of earthquakes within radii of 100 and 200 miles (161 and 322 km) of Modified Mercalli Intensity (MMI) IV (note that an earthquake of Richter Magnitude 4 ~ 5 is comparable to an earthquake with MMI IV ~ V) or greater over the last 100 years are listed in Table 2-4. A total of 24 earthquakes of MMI IV have occurred within 200 miles of the site since 1901. No earthquakes of MMI IV have occurred within 50 miles (80 km) of the site over the last 100 years. The largest magnitude earthquake recorded was magnitude 5.5 in November 1968 at a distance of approximately 172 miles (276 km) from the site.

Table 2-4. Historical Earthquakes Within 200 Kilometers of the JPG

Date	Location		Depth (km)	Magnitude	Distance (km)
	Latitude (degrees)	Longitude (degrees)			
May 17, 1901	38.75	-83.00	NR[1]	4.2	210
September 27, 1909	39.80	-87.20	NR	5.1	189
March 14, 1921	39.50	-87.50	NR	4.4	196
November 27, 1922	37.80	-88.50	NR	4.8	291
April 27, 1925	38.20	-87.80	NR	4.8	217
September 2, 1925	37.80	-87.50	NR	4.6	212
November 5, 1926	39.10	-82.10	NR	3.8	289
September 30, 1930	40.30	-84.30	NR	4.2	192
September 20, 1931	40.43	-84.27	5	4.7	206
March 2, 1937	40.49	-84.27	2	5.0	211
March 9, 1937	40.47	-84.28	3	5.4	209
June 20, 1952	39.64	-82.02	9	4.0	307
January 2, 1954	36.60	-83.70	NR	4.3	286
September 7, 1956	36.44	-83.79	5	4.1	297
November 8, 1958	38.44	-88.01	5	4.4	229
November 9, 1968	37.91	-88.37	21	5.5	276
April 3, 1974	38.55	-88.07	14	4.7	232
January 19, 1976	36.87	-83.86	1	4.0	254
June 17, 1977	40.71	-84.71	1	3.2	220
July 27, 1980	38.19	-83.89	6	5.1	148
June 29, 1984	37.70	-88.47	2	4.1	293
July 12, 1986	40.54	-84.37	10	4.6	213
June 10, 1987	38.71	-87.95	10	5.2	220
September 7, 1988	38.14	-83.88	10	4.6	152

Source: USGS 2001a.
[1]NR = Not reported.
km = kilometer.

A review of the seismicity in this area reveals that the greatest threat at the site could result from the so-called New Madrid Seismic Zone (NMSZ). Based on the Peak Ground Acceleration (PGA) hazard parameters (based on the USGS 2001a) for the JPG Site, an earthquake with a 1,000-year return period could result in a PGA of approximately 0.047 g at the JPG site (U.S Army 2002b).

2.6 WATER RESOURCES

Surface water (Section 2.6.1) and groundwater (Section 2.6.2) hydrology are discussed in this section.

2.6.1 Surface Water Hydrology

Surface water features are abundant at the installation and include ponds, lakes, streams, and wetland areas, along with numerous ephemeral streams, ponding sites, and wet areas. Seven streams and their tributaries drain the JPG area, generally flowing from northeast to southwest, and include Otter Creek, Graham Creek, Little Graham Creek, Marble Creek, Big Creek, Middle Fork Creek, and Harberts Creek (Figure 2-7). JPG lies within the White River Drainage Basin (a sub-basin of the Wabash River Basin, which is a sub-basin of the Ohio River Basin) [U.S. Army 1995b].

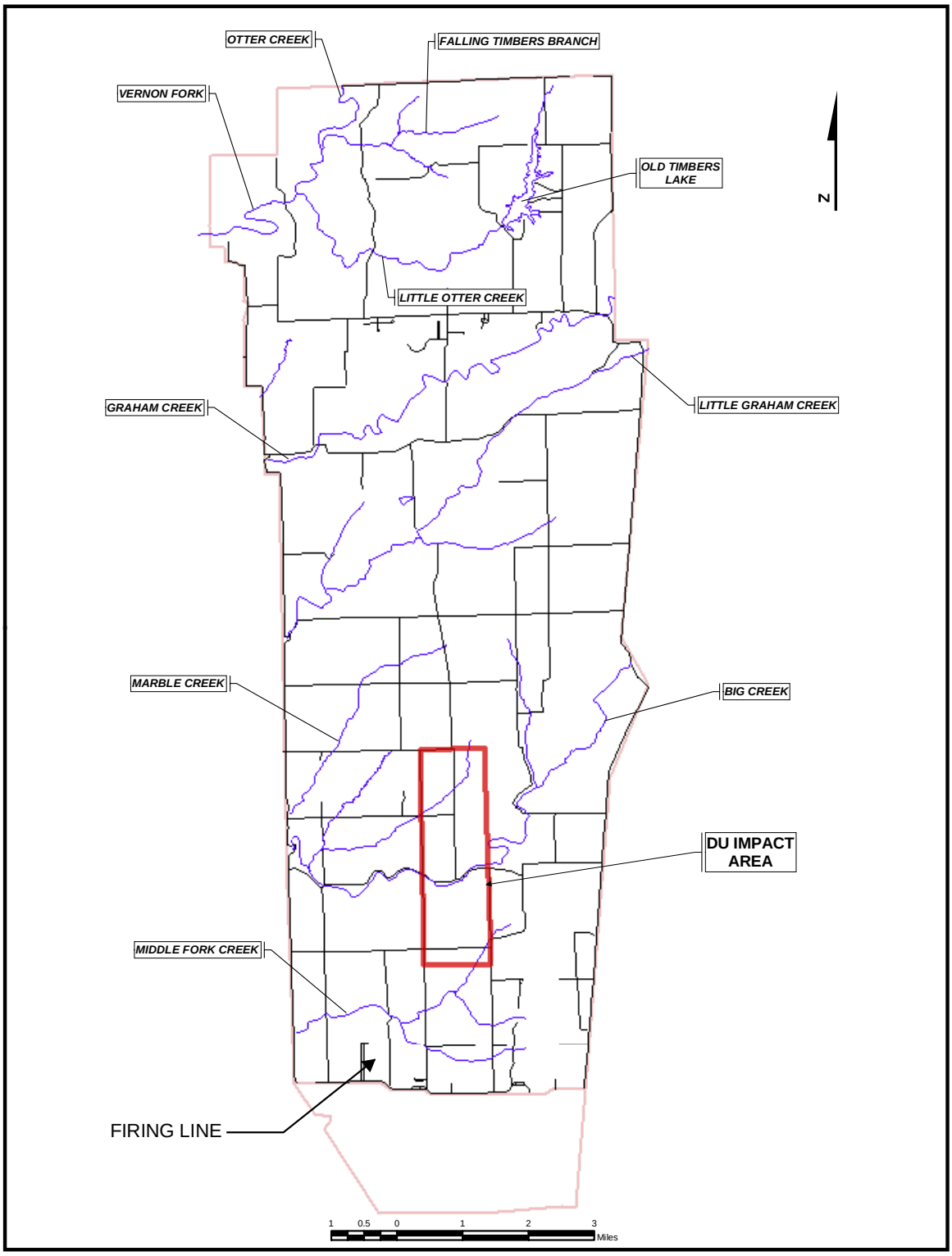
JPG is located in the Muscatatuck watershed of the White River Drainage Basin. EPA's Index of Watershed Indicators (IWI) rates the condition and vulnerability of aquatic systems in the United States. The overall IWI score for this watershed is 3, which indicates "Less Serious Water Quality Problems - Low Vulnerability to stressors such as pollutant loadings" (see http://cfpub.epa.gov/surf/huc.cfm?huc_code=05120207). Additional information is provided in the White River Basin Study (USGS 2001b).

Big Creek bisects the DU Impact Area, and Middle Fork Creek crosses the southeastern DU Impact Area boundary, as shown in Figure 2-7. Big Creek originates off-site and flows 9.2 stream miles across JPG. It is fed by numerous unnamed intermittent tributaries and has a sandy/gravelly substrate. Middle Fork Creek originates on JPG and is fed by several unnamed intermittent tributaries. It has a gravel substrate and meanders 2.6 miles across the facility, draining 6,520 acres. Information on the other five streams is provided in the Final EIS for Disposal and Reuse of the JPG (U.S. Army 1995b). The DP includes estimates of the flood flow and associated sediment transport and yield (U.S. Army 2002b). For a 10-year return period, for instance, the peak flow rate is 5,159 cfs (146 m^3/s) and the sediment yield is 66,973 tons (60,757 metric tons).

Surface water is not used as a domestic drinking water supply in the vicinity of JPG; its primary use is for recreation and livestock watering (MWH 2002). Within the Big Oaks NWR, fishing is permitted only at the 165-acre Old Timbers Lake (FWS 2001b). The streams have no segments listed in the Nationwide Rivers inventory, nor are they a part of the National Wild and Scenic Rivers System (Mason and Hanger 1992). All surface water bodies at JPG are classified as "warm-water aquatic and full-body contact" by the State of Indiana water quality standards (Clark 1993).

Flooding is common in southeastern Indiana because of the proximity to the Ohio River. One major flood has occurred along the Ohio River in southeastern Indiana since 1998. Heavy rains also may cause the tributaries of the Ohio River that cross JPG (i.e., Big Creek) to swell (MWH 2002).

At least 10 ponds or lakes that vary in size from less than 1 acre to 165 acres (0.004 to 0.7 km^2) are located on the installation. No ponds or lakes are located in the DU Impact Area.



Source: MWH (2002).

Figure 2-7. Surface Water Drainage at Jefferson Proving Ground

Water quality, biological, and physical data available on EPA's STORET (short for STOrage and RETrieval) do not include any of the streams on JPG. Surface water sampling data involving total uranium concentrations are available for Big Creek and Middle Fork Creek and are discussed in Section 3.1 of this report. There are no surface water or subsurface uses (e.g., withdrawals, consumption, or returns) currently within the installation boundaries. There is no evidence of past, current, or future pollutant sources with discharges to water in the area north of the firing line, which includes the DU Impact Area (U.S. Army 1995b; Mason and Hanger 1992). Detailed flow information on these streams (e.g., historic monthly flow information, drought stages and discharges by month, and short-duration flow fluctuations) is not available for the JPG streams. Current Federal Emergency Management Agency data (see http://www.fema.gov/mit/tsd) indicate that JPG is not located within a floodplain.

2.6.2 Groundwater Hydrology

In this section the hydrostatic units are described (Section 2.6.2.1). Groundwater use and off-site groundwater wells are identified in Sections 2.6.2.2 and 2.6.2.3, respectively.

2.6.2.1 Hydrostatic units

Three hydrostratigraphic units are located in the JPG area. The unconsolidated glacial deposits underlying the site form one unit. The Paleozoic limestones and dolomites that underlie the unconsolidated glacial deposits form a second unit. The third hydrostratigraphic unit consists of the alluvial deposits in the Ohio River Valley south of the installation.

Unconsolidated Glacial Deposits

The unconsolidated glacial deposits range in thickness from 4 to 43 ft (1.2 to 13.1 m) south of the firing line and are composed predominantly of glacial till (MWH 2002). The hydraulic conductivity of the till ranges from 1.1×10^{-5} to 3.3×10^{-5} in./sec [2.9×10^{-5} to 8.4×10^{-5} centimeters per second (cm/sec)] based on slug tests in wells (Rust E&I 1998; MWH 2002). The direction of groundwater flow is roughly the same as the surface water drainage, which is to the west-southwest over most of the installation. The matrix hydraulic conductivity of the tills at JPG ranges from 1.3×10^{-5} to 3.9×10^{-5} in./sec (3.4×10^{-8} cm/sec to 9.8×10^{-8} cm/sec) [MWH 2002]. Small-scale fractures and sand lenses within the till contribute to the higher hydraulic conductivity measured by the slug tests.

Silurian and Devonian Limestones and Dolomites

The shallow bedrock groundwater in the vicinity of JPG is stored primarily in the bedrock hydrostratigraphic unit comprised of Silurian and Devonian limestones and dolomites members. The aquifer is unconfined to semi-confined and is recharged by infiltration of precipitation to the bedrock aquifer concentrated along fractures within the glacial till and in areas where the creek channels are losing water to the groundwater system. Groundwater in the bedrock shows a direct and rapid response to changing climatic conditions (MWH 2002).

Groundwater flow in the bedrock aquifer is controlled primarily by fractures. The bedrock aquifer is unconfined and recharged by surface water flow. In areas where the overlying till is not fractured, the groundwater in the bedrock aquifer appears to be confined. Cores of limestone bedrock from the site contained fractures 3.94×10^{-3} in. (100 µm) or larger and showed evidence of solutioning (MWH 2002).

Karst features, such as sinkholes, have been recognized along the Otter Creek and Big Graham Creek drainages a few miles west of JPG; however, no karst features have been mapped at JPG (MWH 2002).